

Echo Lake Water Quality

*A Report on Water Quality Monitoring Results
for Water Year 2009 at Echo Lake*



Echo Lake, 2007

Photo by Beth Cullen

Prepared for the City of Shoreline
by the King County Lake Stewardship Program

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King County

Overview

The King County Lake Stewardship Program (KCLSP) began working with volunteer monitors to monitor Echo Lake in 2001. The lake was not monitored in 2002, but work resumed in 2003. In 2005, City of Shoreline staff members began monitoring the lake according to the procedures and schedule of the volunteer monitoring program run through the KCLSP. The water quality data indicate that currently the lake is moderate to high in primary productivity with fair water quality.

This report refers to two common measures used to predict water quality in lakes. The Trophic State Index or TSI (Carlson 1977) is a method of calculating indicators from collected data that allows comparison between different parameters and predicts the volume of algae that could be produced in the lake. A second measure is the nitrogen to phosphorus ratio (N:P), which is used to predict what groups of algae may become dominant in the lake during certain periods. Both the TSI and N:P ratios have been calculated using the available data collected through the volunteer monitoring program.

The discussion in this report focuses on the 2009 water year. Specific data used to generate the charts in this report can be downloaded from the King County Lake Stewardship data website at:

<http://www.metrokc.gov/dnrp/wlr/water-resources/small-lakes/data/default.aspx>.

Or can be provided in the form of excel files upon request.

Physical Parameters

Water temperatures during the May-October sampling period generally followed a pattern similar to other lakes in the region, with cool temperatures in the spring, followed by summer maximum temperatures occurring between mid-July and mid-August, and temperatures cooling slowly in the fall. Excellent temperature records were kept by City of Shoreline staff performing the monitoring in 2009 (Figure 1). Echo Lake water temperature ranged from 13.5 degrees Celsius to 26.3 degrees Celsius with an average of 19.7. Compared to other lakes monitored through the KCLSP in 2009, Echo Lake is generally in the low to mid range of summer temperature maxima. The peak temperature was in early August and occurred after an abnormally hot spell in the Puget Sound lowland area in July.

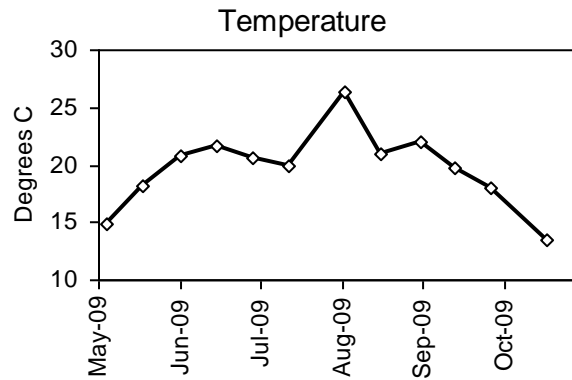


Figure 1. Echo Lake Water Temperatures

Secchi transparency is a common method used to assess and compare water clarity. It is a measure of the water depth at which a black and white disk disappears from view when lowered from the water surface.

For Echo Lake, Secchi transparency values from May through October ranged from 0.6m to 3.5m, averaging 2.4m (Figure 3). Compared to data collected in previous years, the Secchi transparency values exhibited normal and expected variability through the season. The low values in mid-August through September coincided with high chlorophyll values (see later in this report), indicating that decreased transparency was due to an algae bloom.

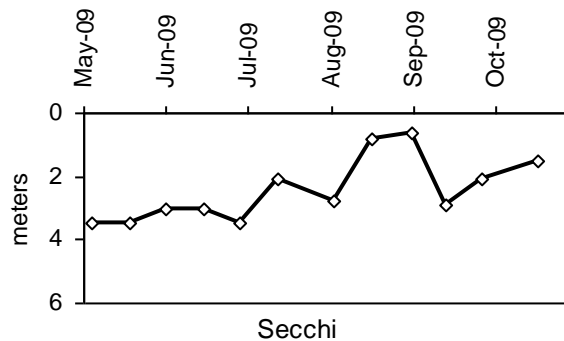


Figure 2. Echo Lake Secchi Transparency

Nutrient and Chlorophyll Analysis

Phosphorus and nitrogen are naturally occurring elements necessary in small amounts for both plants and animals. However, many actions associated with residential development can increase concentrations of these nutrients beyond natural levels. In lakes of the Puget Sound lowlands, phosphorus is often the nutrient in least supply, meaning that biological productivity is often limited by the amount of available phosphorus. Increases in phosphorus concentrations can lead to more frequent and dense algae blooms, making a

nuisance to residents and lake users and a potential safety threat if blooms become dominated by species that can produce toxins. Samples collected by volunteers are analyzed for total phosphorus (TP) and total nitrogen (TN) concentrations at one meter depth.

Total phosphorus (TP) and total nitrogen (TN) varied little from May through July, but both increased in August and then dropped in September through the end of October when they rose again on the last date of sampling (Figure 3). The drastic increase for both TN and TP in August and again in October could be attributed to algae blooms being present.

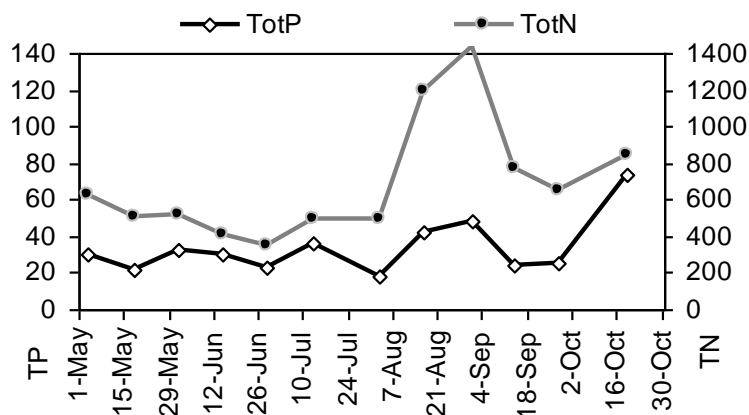


Figure 3. Echo Lake Nutrients

The ratio of nitrogen (N) to phosphorus (P) can be used to determine if conditions are favorable for the growth of cyanobacteria (bluegreen algae) that can impact beneficial uses of the lake. When N:P ratios are below 20, cyanobacteria often dominate the algal community due to their ability to take nitrogen from the air. In 2009, the N:P ratio at Echo Lake ranged from 11.6 to 31.8 with an average of 21.5, which makes the conditions in the lake favorable for bluegreen algae blooms during parts of the sample period. This is consistent with the abundance of bluegreen algae found in the lake at times throughout the season.

Chlorophyll *a* values in 2009 increased greatly from July through early September with a steep drop in mid September, with the values climbing steadily again in October (Figure 4). This may be related to the large-sized colonies found in the lake, which became patchy in distribution across the lake as a result of wind direction, duration, and strength. Accumulations along the shoreline may not be reflected in the smaller concentrations of algae present mid-lake at the designated station.

Pheophytin, a decomposition produce of chlorophyll, remained at low levels throughout the majority of the season except for a very slight increase in October's samples.

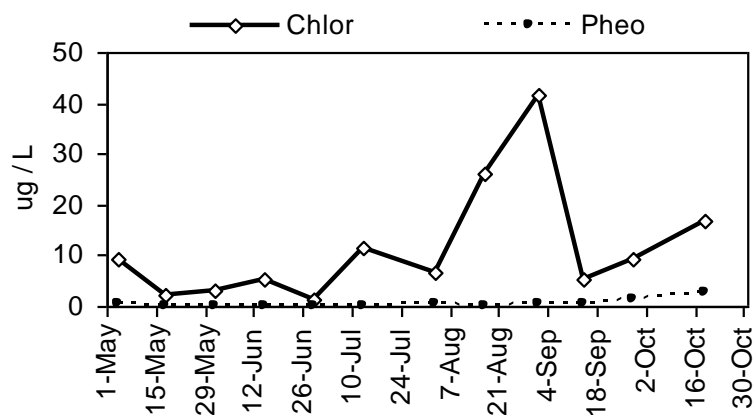


Figure 4. Echo Lake Chlorophyll *a* and Pheophytin Concentrations

Profile data indicate that thermal stratification was present early in the season and persisted through the summer (Table 1). In both events sampled in May and August, the deep (7 m) meter samples had elevated concentrations of phosphorus and orthophosphate. Ammonia concentrations were also high, suggesting that anoxic conditions contributed to the elevated nutrient levels via sediment release.

Table 1: Echo Lake Profile Sample Analysis Results

| Lake name | Date | Secchi | Depth | DegC | Chlor-a | Pheo | Total N | NO2-3 | NH3 | Total P | OPO4 | UV254 | Total Alk |
|-----------|---------|--------|-------|------|---------|--------|---------|-------|-------|---------|--------|-------|-----------|
| Echo | 5/18/09 | 3.5 | 1 | 18.2 | 2.3 | <MDL | 0.503 | 0.067 | 0.018 | 0.0212 | <MDL | 0.099 | 20.5 |
| | | | 3 | 15.0 | 5.6 | 1.3 | 0.491 | | | 0.0263 | | | |
| | | | 7 | 8.3 | 1.0 | 1.4 | 0.920 | 0.071 | 0.603 | 0.1900 | 0.1310 | | |
| Echo | 9/1/09 | 0.6 | 1 | 22.0 | 41.6 | <MDL | 1.440 | <MDL | <MDL | 0.0484 | 0.0030 | 0.134 | 20.7 |
| | | | 3 | 19.0 | 2.7 | 2.3 | 0.588 | | | 0.0205 | | | |
| | | | 7 | 8.0 | 16.4 | ChlorB | 1.340 | <MDL | 1.180 | 0.4780 | 0.1930 | | |

The relatively low values for UV254 indicate that the water of the lake is clear, with little coloration from organic substances, while the total alkalinity values show that the water in the lake is soft and only lightly buffered from pH change. NOTE: In Table 1, <MDL stands for “below minimum detection level” of the analytical method.

TSI Ratings

A common method of tracking water quality trends in lakes is by calculating values for the “trophic state index” (TSI), developed by Robert Carlson in 1977. TSI indicators predict the biological productivity of a lake based on water clarity (Secchi) and concentrations of total phosphorus and chlorophyll *a*.

For Echo Lake, the annual average of the 3 indicators suggests a possible slow decrease in productivity over the period, but it is of low statistical significance (regression correlation coefficient of 0.15). The TSI values remained close to the lower eutrophic range in 2009, slightly higher than in 2008 (Figure 5). The Secchi measurement generally predicted lower algal biovolumes than the other two parameters, which may be due to the clumping or particulate nature of the algal species present. Algae contained in larger

particles do not impact water clarity as much as small algae that produce cloudiness when abundant.

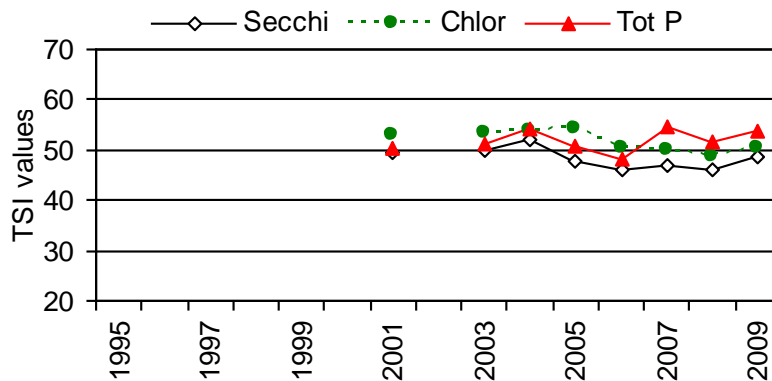


Figure 5. TSI Values at Echo Lake

Cyanobacteria toxins

Because of its history of occasionally producing bluegreen (cyanobacteria) blooms, Echo Lake was chosen as one of 30 Puget lowland lakes to be studied as part of work funded by a grant from the Center for Disease Control (CDC) to the Washington Department of Health, working with the collaboration of King, Snohomish, and Pierce Counties. The study involves regular biweekly sampling at a selected site for bluegreen species abundance and toxicity between June and October for three consecutive years. Blooms will be sampled as well when identified elsewhere in the lake other than the routine sample site. Two algal toxins were measured in 2009, microcystin and anatoxin. Two more toxins will be added in the 2010 and 2011 sampling season; they are saxitoxin and cylindrospermopsin.

In Echo Lake, the routine site chosen was at the public park because that is the point at which the most people and pets come in contact with the water. For most of the 2009 season, toxin measurements were below analytical detection limits. However, beginning in early September, traces of microcystin were found in the water just off the public swimming beach, and remained below the state recreational standard of 6 ug/L until October 5th when a higher value was recorded. On October 9th, the City of Shoreline decided to post a “Caution” sign at the public park warning park visitors of the potential of toxic algae being present. Values continued to be above the 6ug/L throughout October, finally dropping below the 6 ug/L for two consecutive weeks in early November.

Conclusions and Recommendations

Based on the monitoring data, water quality in Echo Lake appears to be stable over the period measured, with a possible small downward trend in phytoplankton productivity, which would need several more years of monitoring for reliable statistical significance. Low N:P ratios in the later part of the monitoring period indicated conditions favorable for nuisance bluegreen algae blooms. Close monitoring of algae blooms at the lake in the fall should continue, including participation in the CDC grant project and the Washington

State Department of Ecology's Toxic Algae Monitoring program to determine whether or not blooms at the lake produce toxins on a regular basis. Continued monitoring of nutrient and chlorophyll concentrations may produce more reliable predictions of future conditions.